book full of information, and illustrated by examples excellently chosen and ably elaborated.

A little adverse criticism may be devoted to the following points:—Proof should surely be given of the important problem (5) on p. 82, for which the reader is referred to works on spherical trigonometry, where he may not find it, or to Reusch's treatise on stereographic projection, which is probably not accessible to him; tetrahedral is a misleading name for the class to which sodium chlorate belongs; τ, being used to indicate tetartohedral classes (p. 149), should scarcely be applied to the trigonal bipyramidal class considered as belonging to the rhombohedral system; the nature of this class and of some others would be much simplified by the modern conception of the simultaneous action of an axis and plane known as "composite symmetry," as one of the general elements of crystal symmetry; this is only alluded to on p. 274, but its introduction as a mode of crystal symmetry would render possible a definition of the tetragonal system by means of its tetragonal axis instead of the somewhat awkward definition on p. 139. Similarly, the joint action of an axis and plane of *twinning* has to be taken into account to explain certain twins of sodium periodate mentioned on p. 359, and is overlooked in the discussion on p. 463. Most readers will find the argument on pp. 258-9 that the conception of merohedrism leads to inconsistencies far from convincing.

In describing the stereographic projection, it is really confusing to the student, and unnecessary, to speak of his eye as being situated on the surface of the sphere. Mention might have been made of the convenient device for crystal drawing described by Maskelyne, under the name crystallograph; and the method of finding the edge between two faces in a perspective drawing by reducing them to a common intercept on an axis, and finding their trace on the other two, might have been introduced into Chapter vi.

If the above be some defects of the book, many are the features in which it is superior to its predecessors.

Among new or specially instructive propositions may be noted the proof relating to tetrad axes on pp. 276-278, and the discussion of indices on pp. 288-295; the proof of the relation between a face and its inverse on p. 356; the propositions in the rhombohedral system relating to Millerian and Naumannian symbols, to indices referred to three and four axes, and to the drawing of the rhombohedron (p. 376). The useful proposition relating to a small circle (p. 83), and its application, are not generally found in text-books. Especially to be commended are the examples illustrative of the drawing of twin crystals. Among the new terms introduced, "stereogram" will doubtless be found serviceable. Finally, as evidence of the up-to-date character of the book, we may note the adoption of Cesaro's proof of the anharmonic ratio, the discussion of Wellsite, and the description of Mr. Smith's three-circle goniometer.

Owing to the author's desire to avoid analytical methods and spherical trigonometry, many of the proofs are somewhat tedious; but Chapter xix. contains analytical proofs and much suggestive material for the more mathematical reader, particularly some propositions relating to the rhombohedral system; *e.g.* the expression for the length of a trapezohedron edge (p. 578).

The book is an eloquent witness to the scientific method of the teaching which Prof. Lewis has carried on at Cambridge for nearly twenty years—teaching to which the present writer is glad to acknowledge his own indebtedness.

The author and the University Press may be congratulated on the completion of a treatise worthy of the subject and of the University. H. A. MIERS.

THE CORRESPONDENCE OF OLBERS AND GAUSS.

Wilhelm Olbers, sein Leben und seine Werke. Im Auftrage der Nachkommen herausgegeben von Dr. C. Schilling. Zweiter Band. Briefwechsel zwischen Olbers und Gauss, Erste Abtheilung. Pp. viii + 767. 8vo. (Berlin: Springer, 1900.)

THE first volume of this work, published in 1894 (NATURE, li. p. 74), contained the collected scientific papers of Olbers; the present one gives the first half (1802-19) of his correspondence with Gauss. These old letters will nearly all be read with great attention by any one interested in the history of astronomy during the early part of this century, as the two correspondents were equally devoted to theoretical and practical astronomy, and discussed new publications and new discoveries in all their bearings. Many readers will perhaps think with the reviewer that here and there some parts of the letters might with advantage have been omitted, and that the editor when leaving out ephemerides of comets and minor planets might have gone further, and have omitted many results of observations, &c., which have been published elsewhere.

The correspondence began in January 1802, when Olbers had just succeeded in recovering the lost planet Ceres by means of the elliptic elements calculated by the young mathematician Gauss by a new method devised by himself. The great sensation which Piazzi's discovery had produced was kept up for some years by the discovery of Pallas, Juno and Vesta, the first and last of these minor planets being found by Olbers, and Juno by Harding, so that (as Gauss remarks) of five planets found in the years 1781 to 1807, the four were found by natives of Hanover. The great respect in which the wonderful success of the computations of Gauss with regard to Ceres were held by astronomers, naturally led to his being left to compute orbits and ephemerides of all the four minor planets, and they consequently occupy a very large part of the letters for the first seven or eight years, until Gauss gradually handed over this work to his pupils. Among many interesting matters connected with the minor planets, which are touched on in the letters, we may mention Olbers' well-known hypothesis as to the origin of these bodies, which directly led him to the discovery of Vesta, also the annoyance of Bode at the discovery of a second planet between Mars and Jupiter, whereby his ideas about the harmony in the solar system were upset. That these new bodies were not followed with the same attention outside Germany is evident from the fact that Vidal, of

Mirepoix, found a planet in December 1804 and observed it for three weeks, without its identity with Ceres being noticed either by him or by Lalande, who christened the new planet by the name of the discoverer, and sent the observations to Germany. Already, in 1802, Gauss sent Olbers a sketch of his new method of computing elliptic elements, and after being more than once urged to bring out a detailed account, he began to work at the "Theoria Motus Corporum Cœlestium" early in 1806, and had it nearly finished in March 1807, when the discovery of Vesta gave him a welcome opportunity to apply his method once more, and particularly to compute an orbit of small inclination from four observations.

As comets were the favourite celestial objects of Olbers, observations and computations on them were on every occasion exchanged by the two correspondents. In 1806 we find Gauss pointing out that Olbers' method of finding a parabolic orbit fails when the direction of the apparent motion of the comet nearly passes through the place of the sun, a fact which Olbers had, however, already noticed, having had his attention drawn to it by a remark of La Place, which had reached him through Burckhardt, and apparently in a mutilated form.

Unlike most great mathematicians, Gauss was exceedingly fond of observatory work, and before his appointment to the Göttingen professorship (in 1807) he repeatedly expressed the wish to become attached to some large observatory, and be relieved from teaching and lecturing, for which he felt no taste. Owing to the disturbed times, the building of the new observatory at Göttingen made very little progress for some years, and Gauss had only the old instruments of Tobias Mayer's Observatory at his disposal. He made diligent use of a small refractor furnished with an annular micrometer; and in January 1808, shortly before Bessel published his paper on this subject, Gauss communicated to Olbers very convenient formulæ for correcting observations with this micrometer for the effect of refraction, based on the idea that within the ring there is visible a part of the sky which may be considered as an ellipse with the major axis vertical. He never published anything on this subject; but in 1830 C. A. F. Peters gave formulæ based on the same idea, though this is not explicitly stated. Again, in 1874, Dr. C. Schrader, in an inaugural dissertation issued at Göttingen, developed similar formulæ without alluding to Gauss, whose ideas on this, as on other methods of reducing observations, have doubtless not been forgotten at the Göttingen Observatory. In a review of this paper (*Vierteljahrschrift*, x. p. 214), Prof. Schönfeld, however, called attention to Gauss' method, with which he had become acquainted through MS. notes of one of Gauss' lectures. The tardy publication of the method in the present volume is most welcome. We notice also some interesting remarks about a small heliometer by Fraunhofer and Reichenbach, received in 1814, and an instructive comparison between it and the old so-called object glass micrometers. This heliometer was in 1874 and 1882 still capable of doing good work in connection with the transits of Venus.

Towards the end of the volume we find Gauss very much occupied with the three new meridian instruments mounted in 1818 and 1819, of which the Repsold transit circle of seven feet focal length and four inches aperture, with a circle read by two microscopes, deserves special mention as the first modern instrument of its kind. It banished mural quadrants and mural circles from the Continent; but, unfortunately, English astronomers thought it necessary to wait a good many years yet before adopting the idea put forward by Römer towards the end of the seventeenth century. In 1817 Gauss expresses the hope that a circle of this kind may soon be established at the Cape, an idea warmly taken up by Olbers, and which bore fruit a few years later when the Royal Observatory at the Cape of Good Hope was established. The Göttingen instruments were almost immediately put to good use in the continuation of the Danish geodetic survey through Hanover, which occupied Gauss (perhaps far too much, as a smaller mind could have done most of the work equally well) for a number of years.

The political events of the time are not infrequently alluded to, though with a certain caution, as it was doubtless not safe to be too outspoken even in private letters. In 1807, we learn, the Leipzig Academy proposed to make a Napoleon constellation of the central part of Orion, and Gauss remarks that this chopping up of old star groups would fitly correspond to the state of things on the earth at that moment. Göttingen formed part of the ephemeral kingdom of Westphalia; while Bremen was, in December 1810, annexed to the French Empire, and formed part of the Département des Bouches du Weser, to the great grief of Olbers, who clung to the old institutions of the free town. He askes Gauss, in August 1811, to tell him as many astronomical news as possible, as scientific and medical journals (except French ones) are strictly forbidden in Bremen. As a member of the Legislative Corps, he had to pay two lengthy visits to Paris in 1812 and 1813, whence he wrote some interesting letters about the meetings of the Academy and the Bureau des Longitudes.

The editor has confined himself to seeing the letters through the press, and appears to have performed this task well; we have only noticed a curious error on p. 504, Bredebour for Lerebours. But he has not given any bibliographical or other references, for which the contents of the letters offer many opportunities, but has only in footnotes given some references to Gauss' collected works and the correspondence between Olbers and Bessel. In one of his few footnotes he makes a mistake, which looks strange in a German book (p. 522); it was in April 1813, during the war of liberation, that Schröter's Observatory was destroyed, and not in December 1812, when everything was quiet throughout Germany. As an example of a place where a footnote ought to have been inserted, we may mention p. 337. Gauss here states that a star occuring in the Histoire Céleste is missing, and suggests that it may have been Vesta. This star (LL46570) is not missing, its place is quite correct, and so far no variability seems to have been detected.

For nearly fifty years the correspondence between Olbers and Bessel has been an astronomical classic, supplemented in 1880 by the publication of that of Bessel and Gauss. The chain is now being completed by the correspondence between Olbers and Gauss, the promised second half of which will no doubt give much valuable information about Gauss' geodetic and magnetic work.

J. L. E. DREYER.